

Self-Reported Minimalist Running Injury Incidence and Severity: A Pilot Study

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Introduction: Minimalist running entails using shoes with a flexible thin sole and is popular in the United States. Existing literature disagrees over whether minimalist running shoes (MRS) improve perceived severity of injuries associated with running in traditional running shoes (TRS). Additionally, the perceived injury patterns associated with MRS are relatively unknown.

Objectives: To examine whether injury incidence and severity (ie, degree of pain) by body region change after switching to MRS, and to determine if transition times affect injury incidences or severity with MRS.

Methods: Runners who were either current or previous users of MRS were recruited to complete an Internet-based survey regarding self-reported injury before switching to MRS and whether self-reported pain from that injury decreased after switching. Questions regarding whether new injuries developed in respondents after switching to MRS were also included. Analyses were calculated using *t* tests, Wilcoxon signed rank tests, and Fischer exact tests.

Results: Forty-seven runners completed the survey, and 16 respondents reported injuries before switching to MRS. Among these respondents, pain resulting from injuries of the feet ($P=.03$) and knees ($P=.01$) decreased. Eighteen respondents (38.3%) indicated they sustained new injuries after switching to MRS, but the severity of these did not differ significantly from no injury. Neither time allowed for transition to MRS nor use or disuse of a stretching routine during this period was correlated with an increase in the incidence or severity of injuries.

Conclusion: After switching to MRS, respondents perceived an improvement in foot and knee injuries. Additionally, respondents using MRS reported an injury rate of 38.3%, compared with the approximately 64% that the literature reports among TRS users. Future studies should be expanded to determine the full extent of the differences in injury patterns between MRS and TRS.

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Despite changes in technology, upgrades in materials, and an increasing variety of shoe options, running overuse injury rates have ranged from about 19% to 79% annually since 1982, according to a 2007 review.¹ That injuries continue to occur suggests that the cushioned heels of traditional running shoes (TRS) may not be providing enough protection, leading some to assert that barefoot or thin leather sandals may help runners avoid the overuse injuries that occur in runners wearing traditional running shoes.² Proponents of barefoot running claim that minimalist running shoes (MRS) (ie, lightweight shoes without a built-up heel and limited padding on the sole) can decrease overuse injuries, and 34.3% of minimalist or barefoot runners cite injury prevention as their main reason for switching shoe type.³ Despite the fact that a lawsuit against an MRS manufacturer was settled regarding at least one type of MRS for the manufacturer's false claims regarding the shoes' health benefits,⁴ there is still demand for such shoes. If runners perceive that MRS cause fewer injuries, then they may be more likely to switch to such shoes.

However, the scientific literature on MRS and their effects on running injuries is equivocal.⁵ For example, Goss and Gross⁶ support the idea that foot injury is reduced in runners using MRS compared with TRS. On the other hand, some research suggests that foot edema⁷ and metatarsal stress fractures⁸ may be more common in runners using MRS. Understanding differences in injury patterns between MRS and TRS is complicated because footwear may cause biomechanical changes⁹ over time.¹⁰ Such changes may reduce injury incidence or severity, but the length of time it takes the body to habituate during this transition period is unknown (likely weeks or months).¹¹ Further complicating the matter is that shoe sellers¹² and various running blogs and publications¹³ suggest a transition period that should include a change in stretching and running routine for an undetermined period. Thus, understanding

perceived injury patterns of minimalist running should include consideration of the time and manner in which the transition to MRS is accomplished.

Physicians rely on objective, scientific literature to advise patients on the benefits and risks of minimalist or barefoot running. To understand how and why patients may present to the primary care office, physicians must also understand people's subjective running experience, their perceived injuries, and how they transition to a different shoe type. Such an understanding will assist physicians in developing patient-centered plans that reduce patients' risk for running injury and that are more likely to be followed by patients. However, information regarding patients' habits and experiences in using MRS is lacking.

We undertook the present pilot study to (1) examine whether self-reported severity of injury (or injury pain) changes when a person switches to MRS, (2) determine which body region injuries (if any) are associated with running in MRS and whether these injuries are influenced by certain characteristics (eg, weekly mileage, age, sex), and (3) determine whether there is a relationship between the time of a self-reported transition period or stretching routine and injury incidence or severity in minimalist runners. With this information, physicians and others involved in the care of runners (eg, athletic specialists) will be able to inform inquiring patients about the perceived benefits and risks of MRS and potential differences in self-reported pain. In addition, such data will help health care professionals to use both subjective and objective data in collaborating to develop or adjust a patient's exercise plan.

Methods

Respondents

Minimalist runners were recruited from July 2013 to July 2014 using a flyer with a Web address and a QR (quick response) code for the online survey. Flyers were posted on Facebook and sent via e-mail to running groups that

Table.
Minimalist Running Injury Incidence and Severity:
Characteristics of Respondents

Parameter	No. (%) ^a		
	Men (n=22)	Women (n=25)	Total (N=47)
Age, y			
18-24	4 (18.2)	3 (12.0)	7 (14.9)
25-34	9 (40.9)	6 (24.0)	15 (31.9)
35-44	6 (27.3)	10 (40.0)	16 (34.0)
45-54	3 (13.6)	5 (20.0)	8 (17.0)
55-64	0	1 (4.0)	1 (2.1)
Height, m, mean (SD) ^b	1.9 (0.4)	1.7 (0.1)	1.8 (0.3)
Weight, kg, mean (SD) ^c	80.6 (13.9)	63.5 (10.5)	71.5 (14.8)
BMI, mean (SD)	23.5 (5.1)	22.8 (3.1)	23.1 (4.1)
Years Running^d			
<1	1 (4.5)	3 (12.0)	4 (8.5)
1	0	1 (4.0)	1 (2.1)
2	0	2 (8.0)	2 (4.3)
3	2 (9.1)	4 (16.0)	6 (12.8)
4	1 (4.5)	1 (4.0)	2 (4.3)
5	1 (4.5)	1 (4.0)	2 (4.3)
>5	17 (77.3)	13 (52.0)	30 (63.8)
Mileage Ran per Week			
0-5	2 (9.1)	2 (8.0)	4 (8.5)
6-10	7 (31.8)	3 (12.0)	10 (21.3)
11-15	5 (22.7)	9 (36.0)	14 (29.8)
16-20	3 (13.6)	5 (20.0)	8 (17.0)
21-30	1 (4.5)	3 (12.0)	4 (8.5)
31-40	1 (4.5)	2 (8.0)	3 (6.4)
41-60	2 (9.1)	1 (4.0)	3 (6.4)
>60	1 (4.5)	0	1 (2.1)
Running Surface^e			
Asphalt	12 (57.1)	15 (60.0)	27 (58.7)
Concrete	1 (4.8)	3 (12.0)	4 (8.7)
Non-asphalt track	0	1 (4.0)	1 (2.2)
Trails	6 (28.6)	4 (16.0)	10 (21.7)
Treadmill	2 (9.5)	2 (8.0)	4 (8.7)

(continued)

the authors were involved with. The flyers were also placed in running stores and distributed at races in multiple states neighboring the authors' home institution and offsite workplace locations. Respondents were required to be aged 18 years or older. The survey excluded runners who solely had experience with TRS. Respondents were not required to meet a weekly mileage for running.

Data Collection

We developed an anonymous online survey (Survey-Monkey) consisting of a minimum of 15 and a maximum of 22 questions. We conducted pilot testing of the questions with 10 traditional runners to revise the instrument. Questions focused on respondents' parameter categories (ie, sex, age, height, weight, miles ran per week, running surface used, length of time using MRS, and transition period for MRS [and use of stretching during transition]) and injury patterns in MRS shoes (ie, "Did you feel that [MRS] provided enough protection against the terrain and elements?" "Were you suffering from a running injury when you switched from [TRS to MRS]?" and "Did you experience any running related injuries AFTER switching to [MRS]?").

For the question regarding severity of existing injuries when switching to MRS, respondents were asked to rate how the injury changed, if at all, using a Likert scale (-5, "injury got much better"; 0, "no change"; 5, "injury got much worse"). Likert scale options were provided for toes, feet, ankles, calves, shins, knees, thighs, hips, and back.

For the question regarding injury severity after switching to MRS, a Likert scale was provided (1, "mild discomfort"; 5, "severe pain"). Options were provided for blisters and discomfort or pain in the toes, feet, calves, shins, knees, thighs, hips, and back.

The survey was available for 1 year. The West Virginia School of Osteopathic Medicine's Institutional Review Board approved this study.

Statistical Analysis

Respondent parameters were grouped into categories based on previous research (eg, weekly mileage,⁶ transition period^{7,14,15}). Parameters were analyzed using Fischer exact test¹⁶ by sex and age category to determine if any effect was present. To determine perceived changes in injury incidence or severity after switching to MRS, a Cramer-von Mises test¹⁷ was used to determine the sample's normal distribution. A *t* test or Wilcoxon signed rank test was used to calculate whether a significant change in perceived incidence or severity of injury occurred.¹⁸

To determine injuries associated with MRS and the influence of respondent parameters, a Wilcoxon sign rank test was calculated to determine whether there was an association between injury incidence and sex, age, or average weekly mileage. A Cramer-von Mises test¹⁷ was calculated to test for normality. A *t* test or Wilcoxon signed rank test was used to calculate whether a significant change in injury severity occurred.¹⁸

We also examined the length of transition period or type of stretching routine and injury incidence or severity. These data were analyzed for injuries associated with MRS, but we compared injuries against stretching routine and transition time rather than sex, age, or average weekly mileage.

A *P* value of .05 or less was considered statistically significant.

Results

Fifty-four runners began the survey, but 6 were excluded because they did not use MRS currently or previously, and 1 was excluded because the survey was not completed beyond the height and weight parameters. Thus, the survey was completed by 47 respondents with experience using MRS. Questions without a response, which may have been logically skipped because of a previous response or skipped by the respondent, were not included in the analyses.

Table (continued).
Minimalist Running Injury Incidence and Severity:
Characteristics of Respondents

Parameter	No. (%) ^a		
	Men (n=22)	Women (n=25)	Total (N=47)
Time in Minimalist Shoes			
<2 weeks	0	2 (8.0)	2 (4.26)
2-4 weeks	0	1 (4.0)	1 (2.1)
4-6 weeks	3 (13.6)	1 (4.0)	4 (8.5)
6-8 weeks	0	1 (4.0)	1 (2.1)
2-4 months	2 (9.1)	4 (16.0)	6 (12.8)
4-6 months	2 (9.1)	2 (8.0)	4 (8.5)
6-12 months	4 (18.2)	3 (12.0)	7 (14.9)
1-2 years	6 (27.3)	6 (24.0)	12 (25.5)
>2 years	5 (22.7)	5 (20.0)	10 (21.3)
Transition Period			
None	5 (22.7)	5 (20.0)	10 (21.3)
1 week	0	2 (8.0)	2 (4.26)
2 weeks	5 (22.7)	6 (24.0)	11 (23.4)
3 weeks	2 (9.09)	5 (20.0)	7 (14.9)
4 weeks	6 (27.3)	3 (12.0)	9 (19.15)
5 weeks	0	0	0
6 weeks	2 (9.1)	1 (4.0)	3 (6.4)
7 weeks	0	1 (4.0)	1 (2.1)
8 weeks	0	0	0
9 weeks	0	0	0
>9 weeks	2 (9.1)	2 (8.0)	4 (8.5)

^a Data presented as No. (%) except where otherwise indicated.

^b Statistically significant difference ($P<.001$), calculated using *t* test.

^c Statistically significant difference ($P=.014$), calculated using *t* test.

^d Women, on average, ran for significantly fewer years than men.

^e One man did not provide a free response question for this parameter, therefore n=21 for men and N=46 for the overall total for this item.

Abbreviation: BMI, body mass index.

General Parameters

Of the 47 respondents, 22 were men and 25 were woman (*Table*). There were no significant differences in sex between respondent parameter categories with the exception of height and weight ($P < .001$ and $P = .014$, respectively).

Injury Severity After Switching to MRS

Of the 47 respondents, 16 (34.0%) indicated that they sustained an injury in TRS before switching to MRS. Injuries of the feet had a mean improvement score of -3.4 (t test, $P = .03$) and injuries of the knee had a mean improvement score of -2.72 (Wilcoxon signed rank test, $P = .01$) (*Figure 1*). When switching from TRS to MRS, no single injury pattern was found to significantly increase in severity (ie, increased pain), but 2 respondents reported an increase in severity (ie, pain) of their injury in both their ankles and calves. Thus, overall for this population, switching to MRS was perceived to improve injury severity in the knees and feet.

Type of Injuries Associated With MRS

Of the 47 respondents, 18 (38.3%) indicated that they sustained a new injury after switching to MRS. No differences were found in injury incidence between sexes. Younger respondents were more likely to perceive an injury in their feet and calves than older respondents. Respondents who ran fewer miles were more likely to perceive an injury in their knees than those who ran more miles per week (*Figure 2*).

In terms of perceived injury severity (ie, degree of discomfort or pain), there was no subset parameter related to injury severity, nor was there any body region in which respondents perceived a statistically significant difference in injury severity. That is, no body region exhibited an injury severity that was statistically significantly different from 0, or no discomfort or pain (*Figure 3*).

Stretching or Transition Time Influence on Perceived Injury Incidence or Severity

Of the 47 respondents with experience in minimalist running, 18 (38.3%) indicated they had an injury after switching to MRS. Of these 18 respondents, 9 used a stretching routine and 5 did not use a stretching routine. Of these 14 respondents indicating a use (or non-use) of a stretching routine, no statistically significant relationship was found between the type of stretching routine and injury incidence or severity in any body region.

Of the 47 respondents with experience in minimalist running, 18 indicated that they sustained an injury after switching to MRS. Of these 18 respondents, 14 indicated that they used a transition period. Of these 14 respondents, no statistically significant relationship existed between length of transition period and injury incidence or severity in any body region.

Discussion

Compared with a larger but similar study by Goss and Gross⁶ our respondents were more equally balanced between men and woman, were slightly younger, ran fewer miles per week, and were less experienced runners. Thus, our data may be more informative about naive or recreational runners.

Changes in Injury Associated With MRS

One-third of respondents had an injury before they switched from TRS to MRS, corresponding with Rothschild's assertion that approximately one-third of runners were interested in MRS as injury prevention.¹⁹ With so many runners interested in MRS for this reason, it is important to determine whether MRS influences perceived injury patterns. The survey results did not reveal any regional injury patterns that statistically worsened after runners transitioned to MRS. Perceived injuries to the feet and knees improved after respondents switched shoe types, contrasting with the findings of Guilianì et al²⁰ and Ridge et al⁷ that stress injuries occurred after runners

adopted MRS. Both of these studies focused on the first 4 to 10 weeks after runners' transitioned, which could be a time of increased risk of injury as the foot adapts to shifting impact and pressure points.

Nearly half of the respondents (45.1%) in the current study had been running in MRS for 1 year or more, at which point their feet would potentially have had time to strengthen and adapt, possibly decreasing their risk of injury. Another study found a decrease in foot, ankle, knee, and hip injuries after 1 year of running in MRS, lending support to these findings.²¹ On the other hand, our data may suggest that, despite an objective increase in injuries when changing to MRS reported elsewhere,¹⁵ some respondents may have perceived that injury severity decreased. Thus, it may be that patients should be cautioned regarding injury risk despite the perceived benefits of switching to MRS.

Injury Patterns of MRS

Eighteen respondents reported that injuries developed after switching to MRS. The calf and shin regions exhibited the highest perceived injury severity (although not statistically significant). Calf pain and discomfort are not surprising—compared with TRS, MRS allow greater ankle range of motion and increased activation of the triceps surae muscles, which could increase Achilles tendon stress. Shin pain after the switch to MRS could result from poor adoption of forefoot striking or poor tolerance of the new shoe type. Other studies have found that the forefoot striking pattern, which is sometimes adopted in minimalist running,^{5,22} decreases shin pain associated with chronic exertional compartment syndrome.²³

Transition Time and Stretching Routine

Nearly 80% of respondents who had an injury after switching to MRS allowed for a transition period to MRS, though no association was found between length of transition and injury incidence. This finding could have been influenced by our small sample size, as it stands to reason that it takes time to adjust to a new

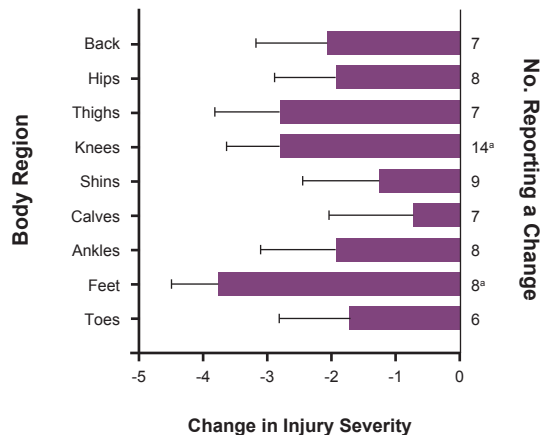


Figure 1.

Mean change in injury severity after switching to minimalist running shoes (MRS) in respondents who had an injury before switching (n=16). Bars represent the mean and the line represents the SE. Numbers next to each bar are the number of the respondents who indicated a change in injury severity to that body region. ^a The knees ($P=.01$) and feet ($P=.03$) had a significant reduction in injury severity; no body region had an overall mean increase in injury severity, but 2 patients reported an increase in severity in both the ankles and calves.

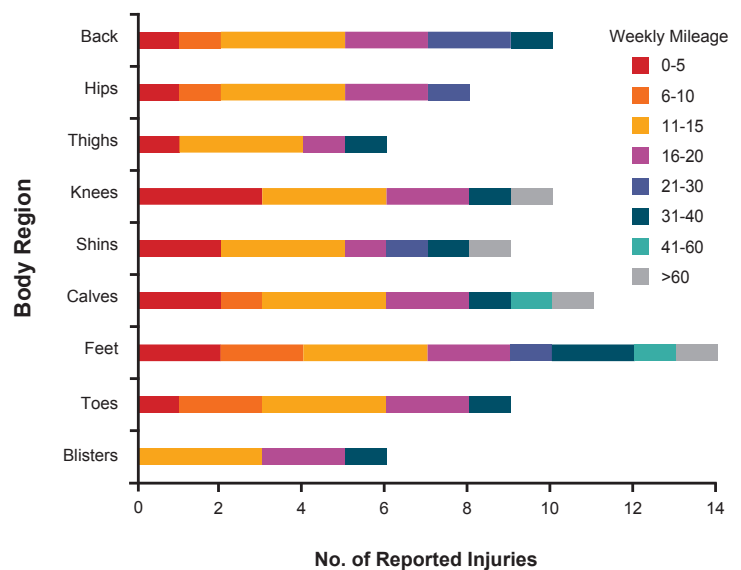


Figure 2.

Data regarding injury incidence in minimalist running shoes (MRS) for each region. Bars indicate total number of respondents who indicated an injury in MRS (n=18). Bars are broken down by weekly mileage. There was no significant relationship between injury incidence and weekly mileage although lower weekly mileage (eg, 6-10 miles, 11-15 miles) seemed to be associated with more injuries.

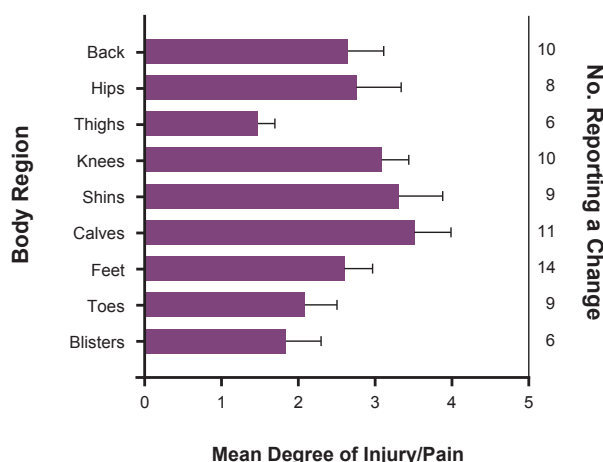


Figure 3.

Mean degree of new injury severity after switching to minimalist running shoes (MRS) (n=18). Bars represent the mean and lines represent the SE. Numbers next to each bar are the number of respondents reporting an injury to that body region. No body region exhibited a significant degree of new injury or pain.

landing pattern. Neither of the runners who sustained metatarsal stress injuries in the study by Giuliani et al²⁰ used a transition period. In addition, only 50% of respondents who sustained an injury after switching to MRS used a stretching routine. Transition periods and stretching routines should continue to be studied to determine their importance in injury prevention.

These data suggest that injuries to the calves and knees should be further explored because patients may be at risk for these injuries when running in MRS. Thus, osteopathic physicians should be mindful of the foot-ankle complex, as well as fibular reciprocal motion. Treatment applied to the fibular head, Achilles tendon, and talus may be appropriate preventive care for patients changing their running shoe type. Osteopathic physicians should check for somatic dysfunction at each check-up and treat patients appropriately with techniques such as strain-counterstrain, muscle energy, and myofas-

cial release.^{24,25} Facilitating these specific body regions to adapt to the new shoe type should help patients maintain—and even enhance—their normal running function. Such a focus on maintenance and enhancement (preventive care) of the musculoskeletal system is a key osteopathic perspective.²⁶

Limitations

Limitations of the present study include the retrospective self-selective survey format and small sample size, which can lead to recall and reliability bias along with only attracting respondents who have strong feelings (positive or negative) about their minimalist running experience.^{27,28} More than a quarter of the respondents no longer ran in MRS. Thus, there may be a bias toward people who currently run in MRS, which may underestimate incidence of injury associated with MRS. Additionally, the injury parameters were not defined for respondents, so reported injuries could be skewed by each individual's definition of injury. However, nearly all of the responses included descriptions of overuse running injuries. Finally, the sample size limited the statistical analyses of injury patterns.

An additional limitation of this study is that self-reported injury changes are not directly comparable between TRS and MRS. For example, the timeframes for injury were not specified in the survey questions. Rather, respondents were asked “Were you suffering from a running injury when you switched from [TRS to MRS]?” This phrasing was chosen to indicate a current injury (rather than, for example, “Had you suffered from a running injury...”). During the survey validation process, no questions were asked regarding the timeframe or how far back to report (for either the TRS or MRS question). It is likely, therefore, that respondents reported on similar timeframes for both injury incidences. However, making comparisons between the incidence and severity of the injuries before and after transition is not possible from our data. Such comparisons would strengthen this study.

Conclusion

In a society battling increasing rates of obesity, running is an easily accessible form of aerobic exercise. However, the high injury rates can discourage participation. Determining the factors that decrease injury rates would allow physicians and other health care professionals to recommend preventive measures to their patients so that running can be safely pursued. Our study found a perceived injury rate of 38.3% in runners wearing MRS, an improvement from the approximately 64% reported by runners in TRS.^{21,29} Although the differences in perceived injury patterns between MRS and TRS have yet to be fully determined, perceived foot and knee pain appears to decrease with MRS. Such results deserve further investigation, particularly if subsequent literature shows an increase in objective injuries with MRS.

Future studies should focus on achieving a larger sample size and prospectively studying injury patterns in 4 groups: minimalist runners who fore- or midfoot strike, minimalist runners who heel strike, runners in TRS who heel strike, and runners in TRS who fore- or midfoot strike. The duration of time between the transition to MRS and injury should also be focused on to determine whether there is an increased injury risk directly after the change of shoe type. Osteopathic physicians should be mindful of the foot-ankle complex, as well as the fibular head, when patients indicate that they are interested in switching to MRS.

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Author Contributions

All authors provided substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; all authors drafted the article or revised it critically for important intellectual content; all authors gave final approval of the version of the article to be published; and all authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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